Structure Protection:
Suppression of Blast Effects from Vehicle Bombs

Session V

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Introduction

Terrorism has long been recognized as a threat to civilian and military forces, both abroad and, to some degree, here in the United States. Recent events well known to the reader have served to enhance and refine this awareness. The Joint Chiefs of Staff deputy director for combating terrorism, Brig. Gen. James Conway, was quoted as saying, "…the greatest threat involves explosive devices." The most deadly explosive devices seen thus far are the infamous large vehicle bombs (LVBs), wherein conventional explosive is disguised within a broad range of vehicle types and sizes. The destructive effects of LVBs can be classified into categories associated with these underlying damage mechanisms:

- Air shock (incident air shocks cause window and masonry breakage and direct injury/death to humans)
- Air blast (detonation products and dynamic pressure loading that causes structural failure/collapse; accelerates debris and causes direct injury and death)
- Fragmentation (primary-bomb vehicle debris; secondary-blast generated debris)
- Thermal loading/fire (hot debris/gases start material and fuel fires and injure personnel).

Reducing the blast effects of an LVB is a central goal in the research fields of structure hardening and suppression-at-the-source efforts. Suppression-at-the-source (or suppression) is achieved by interacting with the LVB as it detonates and diverting some of its destructive energy to non-destructive ends, thus reducing damage to the structure and saving lives. The subject of this paper is such a suppression system.

Battelle led an industrial team that evolved, tested, documented, and demonstrated a practical system to suppress LVB blast effects. This novel system uses commercial-off-the-shelf (COTS) equipment that can be deployed in either a portable or fixed site configuration at affordable prices. This system has been shown to be effective at reducing blast effects by as much as 40-50%, equivalent to a reduction in required standoff distance by 40-60%. The synergistic effects of using this system with current structure hardening technologies could give U.S. assets, both domestic and overseas, a tremendous level of protection immediately for an affordable price.

Proposed Solution

Bulk water has long been used to suppress blast effects. However, it is difficult to get enough water to the right place at the right time fast enough to suppress a large threat such as an LVB. Aqueous foam is an existing alternative but this also presents severe operational problems, such as long times required for emplacement and interference with render-safe operations.

Battelle's previous experience with using water in and around explosives showed that in the right state and configuration, water can:

- Absorb momentum and energy from the shock wave propagating through the air
- Quench the fireball from the expanding detonation products, thus reducing quasi-static pressure.

The practicality of using high-speed spray (suspended) of water is driven by several complex relationships: the weight of water required versus the weight of explosive; droplet size distribution versus distance of travel for water sprays; and multi-phase interactions of the water with the detonation products and shock wave. By understanding this technology and reducing it to practice, Battelle has now designed and can install suppression systems that can protect structures or withstand repeated use in demilitarization applications. Battelle calls this patent-pending, advanced suppression technology the **HydroSuppressor™** system.

Figure 1. Remote Control Monitor

Operational Requirements

The equipment required to support the HydroSuppressor™ system is commonly available as industrial fire fighting equipment. The system uses the following types of components:

- Start switch or panic button (to activate the system to begin dispersing water)
- Pump (to disperse the water and give it the proper distance-throw required)
- Automatic valves (to direct the water flow to the correct monitors)
- Monitors (high output nozzle apparatus seen in **Figure 1** that can be remotely, and automatically, steered to adjust spray location or follow a moving vehicle).

Monitors can provide sufficient flow rates of water in varying spray patterns and can reach as far as 100 feet to provide a large area of coverage.

System Performance

After a series of 88 tests using up to 50 pounds of ammonium nitrate/fuel oil explosive, Battelle is confident in stating that the suppression performance of HydroSuppressor™ is proven. The resulting performance characteristics are:

- 40 - 50% reduction in incident pressure and impulse
- 40 - 50% reduction in reflected pressure and impulse
- 60 - 70% reduction in peak quasi-static pressure
- 40-60% equivalent reduction in required standoff distance (based on peak incident pressure and impulse)

- A system response time of 5 to 8 seconds, once triggered
- No harm to personnel, passersby, the suspect vehicle, or the environment.

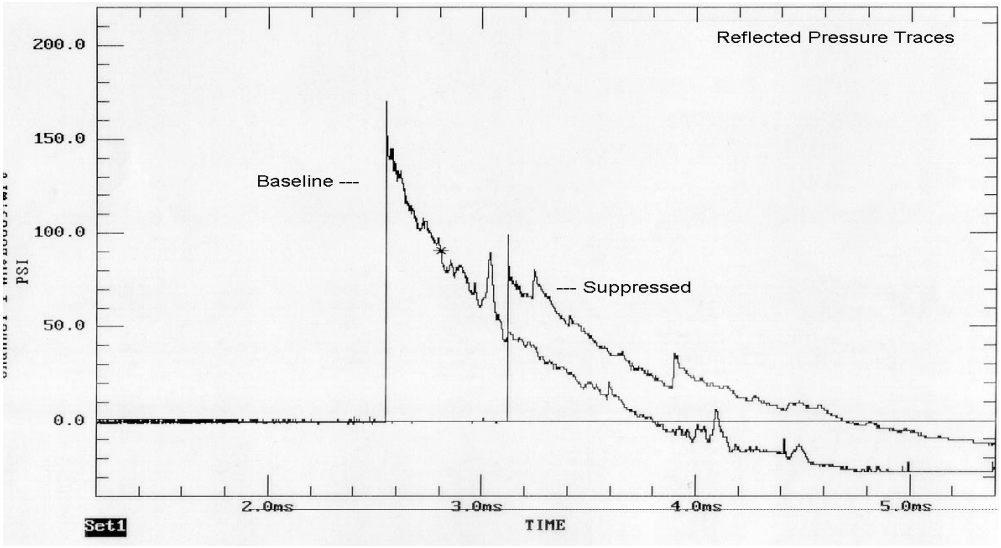

Figure 2 Pressure Curve Comparison

HydroSuppressor™ Operations

The portable version of the HydroSuppressor™ system was twice demonstrated in an open parking lot and then later deployed in two night exercises to a realistic LVB scenario in a downtown Columbus, Ohio parking garage. On the evenings of August 5th and 6th, 1998, Battelle conducted a full scale demonstration/exercise of the mobile version of the HydroSuppressor™ system. No explosives were employed in these demonstrations, which were directed at exploring and demonstrating operational deployment issues.

These demonstrations showed that the system could easily be deployed in a mobile configuration and supported with COTS equipment. However, the main intention of this technology is to be permanently installed at high threat locations so that the system can respond to a threat in a matter of seconds.These demonstrations were attended by personnel representing the Federal Bureau of Investigation's Hazardous Devices School, City of Columbus Bomb Squad, City of Columbus Division of Fire, local bomb squad commanders, local SWAT teams, State of Ohio Emergency Management Agency and Ohio National Guard.

Figure 3. Mobile Application

Figure 4 – Indoor Application

Approximately three hours after the second Battelle demonstration ended two U.S. embassies, one in Kenya and one in Tanzania, suffered devastating vehicle bomb attacks that resulted in over 250 people dead and nearly 5,000 injured. This strange coincidence further underlines the urgent need to field this technology to protect U.S. assets abroad.

Conclusion

Battelle has the capability to deploy vehicle bomb suppression systems based entirely on very mature COTS fire protection technology. Fire protection systems, similar in design to HydroSuppressor™, have been deployed within and outside of the United States in thousands of situations and have proven performance and low-maintenance benefits. It can be deployed in either a portable or fixed site configuration (**Figure 5**) at affordable prices. This system has been shown to be effective at reducing blast effects by as much as 50%. This level of suppression is equivalent to a reduction in required standoff distance by 60%. If the HydroSuppressor™ system is activated for a false alarm

condition, or simply tested, it will only be discharging water and will therefore not have a negative impact on personnel, a suspicious vehicle, or the environment.

The synergistic effects of using HydroSuppressor™ with current structure hardening technologies could give U.S. assets overseas a tremendous level of protection today for an affordable price.

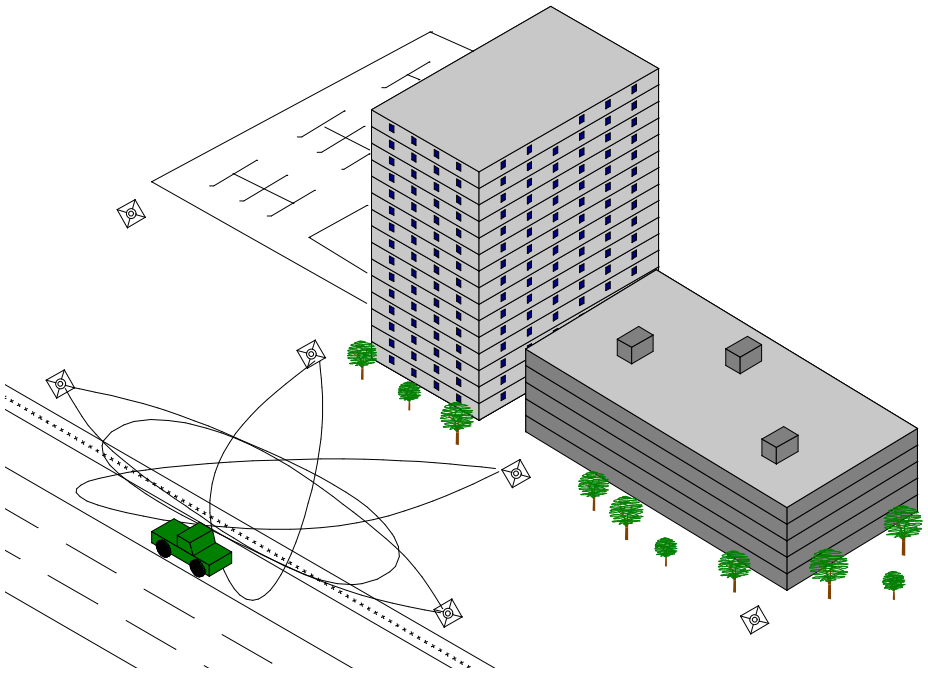

Figure 5 Responsive Structure Protection